

WHAT IS CLAIMED IS:

1     1.     A drilling system for drilling a wellbore, comprising  
2           (a)     a drill string having a drill bit at an end thereof;  
3           (b)     a source supplying drilling fluid under pressure into the drill string (a  
4     “supply fluid”), the drilling fluid returning uphole via an annulus around the drill  
5     string (a “return fluid”);  
6           (c)     a modular tool in communication with the return fluid for reducing  
7     pressure in the wellbore downhole of the modular tool, said modular tool having  
8     at least one interchangeable modular unit;  
9           (d)     an active pressure differential device (“APD Device”) associated  
10    with the modular tool to create a pressure drop across said APD Device to  
11    reduce ; and  
12           (e)     a drive assembly coupled to said APD Device for energizing said  
13    APD Device.

1     2.     The system according to claim (1) wherein said modular unit is provided  
2     as a plurality of modular units, each of which are interchangeable with the other  
3     and each of which has a substantially different value for a selected operating  
4     parameter.

1     3.     The system according to claim (1) wherein said APD Device is said

2 modular unit.

1 4. The system according to claim (3) further comprising a plurality of said  
2 modular units, each of said modular units being configured to have a  
3 substantially different value for a selected operating parameter.

1 5. The system according to claim (4) wherein said selected operating  
2 parameter includes (i) pressure differential in the return fluid; (ii) rotation speed;  
3 (iii) flow rate; and (iv) torque.

1 6. The system according to claim (1) wherein said drive assembly is said  
2 modular unit.

1 7. The system according to claim (6) further comprising a plurality of said  
2 modular units, each of said modular units being configured to have a  
3 substantially different value for a selected operating parameter.

1 8. The system according to claim (7) wherein said selected operating  
2 parameter is one of (i) differential pressure of the supply fluid; (ii) rotation speed;  
3 (iii) flow rate; and (iv) torque.

1 9. The system according to claim (1) further comprising a comminution

2 device for reducing the size of particles entrained in the return fluid, said  
3 comminution device being said modular unit.

1 10. The system according to claim (1) further comprising a high-pressure seal  
2 for controlling the leaking of pressurized drilling fluid from said modular tool, said  
3 high-pressure seal being said modular unit.

1 11. The system according to claim (1) further comprising an annular seal for  
2 directing return fluid into said modular tool, said annular seal being said modular  
3 unit.

1 12. A drilling system for drilling a wellbore, comprising

2 (a) a drill string having a drill bit at an end thereof;

3 (b) a source of drilling fluid supplying drilling fluid under pressure into  
4 the drill string (a "supply fluid"), the drilling fluid returning uphole via an annulus  
5 around the drill string (a "return fluid");

6 (c) an active pressure differential device ("APD Device") associated  
7 with the return fluid to create a pressure drop across said APD Device to reduce  
8 pressure in the wellbore downhole of the APD Device;

9 (d) a drive assembly coupled to said APD Device for energizing said  
10 APD Device; and

11 (e) a high-pressure seal associated with said drive assembly, said seal

12 configure to provide a controlled leakage of pressurized drilling fluid out of said  
13 drive assembly.

1 13. The drilling system according to claim (12) wherein said high-pressure  
2 seal is configured to operate as a radial bearing for providing lateral stability a  
3 shaft associated with said drive assembly.

1 14. The drilling system according to claim (12) wherein said high-pressure  
2 seal comprises a plurality of seal elements.

1 15. The drilling system according to claim (12) wherein said high-pressure  
2 seal is configured to provide a leak rate of fluid for cooling and lubricating a  
3 bearing.

1 16. The drilling system according to claim (12) wherein said high-pressure  
2 seal comprises a concentrically arranged inner sleeve and outer sleeve, said  
3 inner sleeve being fixed on a shaft assembly associated with the drive assembly  
4 and said outer sleeve being fixed to a housing associated with the drive  
5 assembly.

1 17. The drilling system according to claim (12) wherein said high-pressure  
2 seal includes one of (i) a hardened surface, and (ii) a hardened insert to reduce

3 frictional wear.

1 18. The drilling system according to claim (12) wherein said high-pressure  
2 seal is formed as a modular unit.

1 19. A method of constructing a tool for reducing pressure in the wellbore  
2 downhole of the modular tool, comprising:

3 (a) providing a plurality of modular units, said modular units being  
4 selected from a group consisting of: (i) an active pressure differential device  
5 module (APD device module) for creating a pressure differential in a fluid  
6 returning from a drill bit; (ii) a drive module for energizing the APD Device  
7 module; (iii) a comminution device module for reducing the size of cutting in the  
8 wellbore; (iv) an annular seal module for directing fluid into the APD Device  
9 module; and (v) a high-pressure seal module for substantially sealing a  
10 pressurized fluid in the drive module;

11 (b) assembling the plurality of modular units into a plurality of tool sub-  
12 assemblies; and

13 (c) assembling the plurality of tool sub-assemblies into a modular tool  
14 for reducing pressure in the wellbore downhole of the modular tool.

1 20. A method for drilling a wellbore, comprising

2 (a) providing a drill string having a drill bit at an end thereof;

- 3           (b)     supplying drilling fluid under pressure into the drill string (a “supply  
4 fluid”), the drilling fluid returning uphole via an annulus around the drill string (a  
5 “return fluid”);
- 6           (c)     positioning a modular tool in communication with the return fluid for  
7 reducing pressure in the wellbore downhole of the modular tool, said modular  
8 tool having at least one interchangeable modular unit;
- 9           (d)     creating a pressure drop in the return fluid using an active pressure  
10 differential device (“APD Device”) associated with the modular tool; and
- 11          (e)     energizing the APD Device with a drive assembly.

1   21.    The method according to claim (19) wherein said modular unit is provided  
2 as a plurality of modular units, each of which are interchangeable with the other  
3 and each of which has a substantially different value for a selected operating  
4 parameter.

1   22.    The method according to claim (19) further comprising forming the APD  
2 Device as the modular unit.

1   23.    The method according to claim (21) further comprising forming the APD  
2 Device as a plurality of modular units, each of the modular units being configured  
3 to have a substantially different value for a selected operating parameter  
4 selected from one of (i) pressure differential in the return fluid; (ii) rotation speed;  
5 (iii) flow rate; and (iv) torque.

1 24. The method according to claim (19) further comprising forming the drive  
2 assembly as the modular unit.

1 25 The method according to claim (21) further comprising forming the  
2 modular units as a plurality modular units, each of said modular units being  
3 configured to have a substantially different value for a selected operating  
4 parameter selected from one of (i) differential pressure of the supply fluid; (ii)  
5 rotation speed; (iii) flow rate; and (iv) torque.

1 26. The method according to claim (19) wherein the modular unit is selected  
2 from one of (i) a comminution device for reducing the size of particles entrained  
3 in the return fluid, (ii) a high-pressure seal for minimizing the leaking of  
4 pressurized drilling fluid from the modular tool, and (iii) an annular seal for  
5 directing return fluid into the modular tool.

1 27 A method for drilling a wellbore, comprising  
2 (a) a drill string having a drill bit at an end thereof;  
3 (b) supplying drilling fluid under pressure into the drill string (a "supply  
4 fluid"), the drilling fluid returning uphole via an annulus around the drill string (a  
5 "return fluid");  
6 (c) positioning an active pressure differential device ("APD Device") in  
7 communication with the return fluid to create a pressure drop across said APD  
8 Device to reduce pressure in the wellbore;

9 (d) energizing the APD Device with a drive assembly coupled to the  
10 APD Device; and

11 (e) sealing the pressurized drilling fluid in the drive assembly using a  
12 high-pressure seal having a pre-determined rate of leakage.

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1 28. The method according to claim (26) further comprising providing lateral  
2 stability for a shaft associated with the drive assembly using the high-pressure  
3 seal.

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1 29. The method according to claim (26) further comprising cooling and  
2 lubricating a bearing using the drilling fluid leaked through the high-pressure  
3 seal.

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1 30. The method according to claim (26) wherein the high-pressure seal  
2 comprises a concentrically arranged inner sleeve and outer sleeve, the inner  
3 sleeve being fixed on a shaft assembly associated with the drive assembly and  
4 the outer sleeve being fixed to a housing associated with the drive assembly.